DASHMAT WITH COMPONENT GAP SEAL

DESCRIPTION

Cross-reference to related application

[Para 1] This application claims the benefit of U.S. provisional application Serial No. 60/481,286, filed August 25, 2003, which is incorporated herein by reference in its entirety.

Field of the Invention

[Para 2] This invention relates to a vehicle dashmat with an acoustic seal. In one of its aspects, the invention relates to a vehicle with a dashmat that has an improved acoustic seal for reducing transmission of noise through an opening in the vehicle firewall and the dashmat and from the engine compartment of a vehicle into the passenger compartment. In another of its aspects, the invention relates to a dashmat having an improved acoustic seal for an opening in the dashmat.

Description of the Related Art

[Para 3] Motor vehicles have a steel firewall between the engine compartment and the passenger compartment. It has been a common practice in the automotive industry to employ an acoustic barrier system between the firewall and the passenger compartment of the vehicle to reduce noise from the engine compartment into the passenger compartment. Figure 1 illustrates

an example of a prior art firewall 10 separating an engine compartment 11 from a passenger compartment 15, with a noise-reducing dashmat 12 placed along the passenger compartment side of the firewall 10. The dashmat 12 generally comprises a relatively dense, resilient barrier layer 13 that reflects sound back toward its source, and a foam or fiber sound-absorbing material 14 intermediate the firewall 12 and the barrier layer 13.

[Para 4] Various components 16 can be installed in the passenger compartment 15 over the dashmat 12. Apertures 19, 17 through the firewall 10 and dashmat 12, respectively are provided for conduits 18 used to convey fluids and/or electrical power to and from the components 16. As shown in Figure 1, moisture seals 20 are used to fill any space between the conduits 18 and the apertures 17, 19 to prevent water or other materials from entering the passenger compartment 15 and, to a lesser extent, reduce the amount of noise entering the passenger compartment 15. The seal 20 can be made of a moisture-impermeable foam, such as expanded polyurethane or foam rubber. However, noise from the engine compartment 11 can pass through the foam seal 20, which is a relatively weak acoustic barrier, and along a path, such as the sound path 22 illustrated in Figure 1, between the automotive component 16 and the dashmat 12, into the passenger compartment. The primary purpose of the seal 20 is to provide moisture and debris sealing, with acoustic barrier properties being of secondary importance.

[Para 5] U.S. Patent No. 5,975,609 to Campbell discloses a boot for acoustically sealing a steering column, which is integrally molded with a dashmat attached to a motor vehicle firewall. The boot comprises a single-layer sound barrier having a flexible configuration for accommodating the steering column.

[Para 6] U.S. Patent No. 6,070,928 to Campbell discloses a dashmat having a pair of opposed, cooperative doors integrated therein in register with openings in the dashmat and an underlying firewall for acoustically sealing a conduit extending through the openings.

[Para 7] An acoustic barrier designed to block the transmission of sound through a firewall aperture into the passenger compartment is disclosed in

U.S. Patent No. 5,557,078 to Holwerda. Holwerda '078 discloses a dashmat having a pass-through aperture circumscribed by an inwardly-extending, flexible, flap-type seal which engages the periphery of a pass-through component.

Summary of the Invention

[Para 8] In a motor vehicle that includes an engine compartment and a passenger compartment that are separated by a firewall containing at least one opening therethrough for passage of a conduit. A sound attenuating dashmat is mounted to the firewall along the passenger compartment side and has an opening in registry with the at least one opening in the firewall. A vehicle component is mounted to the firewall in the passenger compartment adjacent the openings in the firewall and the dashmat and may communicate with the conduit. An acoustic seal according to the invention surrounds the openings in the firewall and the dashmat and extends upwardly from an upper surface of the dashmat toward the passenger compartment, the acoustic seal having sound absorbing and sound barrier components to attenuate sound that passes through the openings in the firewall and the dashmat and above the upper surface of the dashmat so that the acoustic seal interrupts the transmission of sound from the engine compartment into the passenger compartment of the motor vehicle.

[Para 9] The acoustic seal further comprises an upwardly extending side wall and a top wall of a sound barrier material. The sound barrier material comprises a dense, resilient, flexible synthetic resin, such as a filled thermoplastic elastomer, an unfilled thermoplastic elastomer, an elastomer-modified polyurethane, a thermoset plastic, a polyurethane, or a thermoplastic. The acoustic seal side wall can be integrally formed with the sound barrier of the dashmat, or can be formed separately from the sound barrier of the dashmat.

[Para 10] The acoustic seal further comprises a sound absorber material comprising a low density, porous material, such as expanded flexible polyurethane, a flexible fibrous material, a non-woven glass fiber mat, or shoddy cotton. The sound absorber material can have a central opening for passage of the conduit and can be in the shape of an annular body that is integrally formed with the sound absorbing layer of the dashmat. Alternatively, acoustic seal sound absorber material can be formed separately from the sound absorbing layer of the dashmat and fastened to the sound absorbing layer.

[Para 11] The dashmat comprises a barrier layer and a sound absorbing layer. The barrier layer comprises a dense, resilient, flexible synthetic resin, such as barium sulfate filled polypropylene, a thermoplastic elastomer, an elastomer-modified polyurethane, a thermoset plastic, a polyurethane, or a filled thermoplastic. The sound absorbing layer comprises a foam plastic, such as an expanded flexible polyurethane, a flexible fibrous material, a nonwoven glass fiber mat, or a shoddy cotton.

[Para 12] The acoustic seal can be in contact with the vehicle component when the vehicle component is mounted to the firewall.

[Para 13] Further according to the invention, a dashmat for mounting in a vehicle firewall that separates an engine compartment from a passenger compartment and wherein the firewall has at least one opening for passage of a conduit therethrough, has an acoustic seal that surrounds an opening the dashmat. The acoustic seal surrounds the opening in the dashmat and extends upwardly from an upper surface of the dashmat. The acoustic seal has sound absorbing and sound barrier components to attenuate sound that may pass through the openings in the firewall and the dashmat and above the upper surface of the dashmat when the dashmat is mounted to the firewall to thereby attenuate the transmission of sound through the opening in the dashmat.

[Para 14] Still further according to the invention, an acoustic seal for surrounding an opening in a substrate having an obverse surface and a reverse surface has a collar that is mounted on the obverse surface, surrounds the

opening and has sound absorbing and sound barrier components to attenuate sound that passes through the opening in the substrate. The acoustic seal extends generally perpendicular from the obverse surface of the substrate. The acoustic seal interrupts the transmission of sound through the opening in the substrate from the reverse side to the obverse side of the substrate.

Brief Description of the Drawings

[Para 15] Figure 1 is a schematic cross-sectional view of a prior art assembly comprising a pass-through component mounted to a motor vehicle firewall separating an engine compartment from a passenger compartment and showing a sound path from the engine compartment to the passenger compartment.

[Para 16] Figure 2 is an exploded view from the passenger compartment of the motor vehicle of a portion of the firewall, the pass-through component, and an acoustic seal according to the invention.

[Para 17] Figure 3 is a schematic cross-sectional view similar to the view illustrated in Figure 1 of the pass-through component mounted to the firewall with the acoustic seal illustrated in Figure 2.

[Para 18] Figure 4 is a close-up perspective view of the component with an attached conduit and the acoustic seal illustrated in Figure 1.

[Para 19] Figure 5 is a cross-sectional view of a portion of the conduit and the acoustic seal illustrated in Figure 4 taken along view line 5-5.

[Para 20] Figure 6 is a cross-sectional view similar to that illustrated in Figure 5 of a second embodiment of the acoustic seal.

Description of an Embodiment of the Invention

[Para 21] Referring now to the drawings and to Figures 2 and 3 in particular, a generally conventional firewall 10 separates an engine compartment 11 from a passenger compartment 15 of a vehicle. The inventive acoustic barrier system described herein shares several elements of the prior art acoustic barrier system described previously. Thus, like identifying numerals will be given to like elements shared by the prior art and the invention. The firewall 10 has a number of openings 19 therethrough (only one of which is shown in Figure 3). The view in Figure 2 is from the passenger compartment. It should be noted that the invention is illustrated in the context of a vehicle firewall for exemplary purposes only, and that the invention is not limited by the examples described herein. In particular, the invention is not limited to use with a two-layer dashmat described herein, but can be used with any dashmat that has both barrier and absorption properties, including single layer firm-flexible foam. An example of a firm flexible foam suitable for a dashmat is described in International Publication No. WO 2004/062966 A2, published July 29, 2004, and entitled "Molded Lightweight Foam Acoustical Barrier And Method Of Making Same," which is incorporated by reference as though set forth fully herein. In fact, the acoustic seal can be used to attenuate sound through any opening in a substrate, regardless of the nature of the substrate.

[Para 22] A dashmat 12 is located along the passenger compartment side of the firewall 10 and comprises a barrier layer 13 and a sound absorbing layer 14. The barrier layer 13 has an upper surface 13a facing the passenger compartment, as illustrated in Figure 4. The barrier layer 13 and the sound absorbing layer 14 have an opening 17 therethrough. The barrier layer 13 is typically made of a relatively dense, resilient or flexible synthetic polymer, such as a barium sulfate filled polypropylene, a thermoplastic elastomer, elastomer-modified polyurethanes, thermosets such as polyurethanes, or other filled thermoplastic materials. The sound absorbing layer 14 is typically a foam material, such as expanded flexible polyurethane, or a flexible fibrous material, such as a nonwoven glass fiber mat, shoddy cotton, or other relatively low density, porous sound-absorbing material that is commonly employed to absorb sound and/or act as a decoupling layer in an acoustic barrier assembly. The sound absorbing layer 14 is typically bonded to the

barrier layer 13 so that it is interposed between the barrier layer 13 and the firewall 10 when the dashmat 12 is installed in the motor vehicle.

[Para 23] An automotive pass-through component 16, which can comprise an HVAC unit, an electrical control box, or the like, is shown in Figures 2-4 mounted on the passenger side of the firewall 10 adjacent the dashmat 12. An aperture 17 is provided through the barrier layer 13 and the sound absorbing layer 14 in registry with each other and the opening 19 through the firewall 10 to enable a conduit 18, such as a fluid-conveying tube or a wiring harness, to extend from the automotive component 16 to the engine compartment when the automotive component 16 is attached to the firewall 10. As shown in Figure 2, several openings 17, 19 can be provided for different components.

[Para 24] An acoustic seal 24 according to one embodiment of the invention comprises a donut-shaped annular body or collar adapted to coaxially circumscribe the aperture 19 and the conduit 18 above the surface of the barrier layer 13. As shown in Figures 3-5, the annular body of the acoustic seal 24 is formed in part by a sound barrier layer 28 in the form of an upwardly extending side wall 32 and an annular top wall 34 of the of the sound barrier layer 13. In a preferred embodiment, the side wall 32 and the top wall 34 are integrally formed with the barrier layer 13 although the side wall 32 and the top wall 34 can be formed separately and attached in a suitable manner to the barrier layer 13 after molding of the barrier layer 13, such as with an adhesive 36, as illustrated in Figure 6, or other suitable fastener. Although the shape of the acoustic seal 24 is shown as donut-shaped, the configuration of the seal 24 can take many forms so long as the shape extends upwardly from the barrier layer and has an opening that extends through the body. Thus, the shape can be square, oblong, rectangular, pentagonal, hexagonal, and the like.

[Para 25] The acoustic seal 24 is also formed in part by an annular body 30 of a sound adsorbing material such as expanded flexible polyurethane, or a flexible fibrous material, such as a non-woven glass fiber mat, shoddy cotton, or other relatively low density, porous sound-absorbing material that is commonly employed to absorb sound and/or act as a decoupling layer. The

annular body can be formed of the same material as the decoupling layer 14 or of a different material. Preferably, the annular body 30 is integrally formed with the sound absorber layer 14, although it can be separately formed and attached in a suitable manner to the sound absorber layer 14 before installation of the component 16, such as with an adhesive 38, as illustrated in Figure 6, or other suitable fastener.

[Para 26] The sound barrier layer 28 is a relatively dense, resilient or flexible synthetic plastic material, such as a filled or unfilled thermoplastic elastomer, elastomer-modified polyurethanes, thermosets such as polyurethanes, or other thermoplastic materials. The acoustic seal 24 is shown in Figures 4 and 5 as concentrically spaced away from the conduit 18, although the acoustic seal 24 can be adapted for slidable communication with the conduit 18.

[Para 27] As shown in Figures 4 and 5, the acoustic seal 24 extends above the top surface 13a of the dashmat 12 a sufficient height to interrupt the sound, illustrated in Figure 5 by the sound path 26, and prevent its entry into the passenger compartment. The reduction in noise is primarily a function of the height of the acoustic seal 24, rather than its concentric proximity to the conduit 18. The automotive component 16 can be positioned either in contact with the acoustic seal 24, as shown in Figure 3, or spaced a small distance away from the acoustic seal 24 with relatively little effect on sound reduction.

[Para 28] It is anticipated that the acoustic seal 24 will be integrally formed with the dashmat 12 as a generally thickened portion thereof, as shown in Figure 5. Alternatively, the acoustic seal 24 can comprise a separate element for selective installation depending upon the type and location of the automotive component(s) 16 to be installed, as shown in Figure 6.

[Para 29] During vehicle assembly, the dashmat 12 will be typically installed against the firewall 10, followed at some later time by installation of the automotive component 16. The automotive component 16 will be installed by inserting the conduit 18 through the aperture 19, with the moisture seal 20 previously attached to the conduit 18 to seal the space between the conduit 18 and the aperture 19, followed by attaching the automotive component 16 to the firewall 10 through suitable conventional fasteners, as shown schematically

in Figure 3. With the acoustic seal 24 integrated with the dashmat 12, the seal 24 will be properly positioned relative to the component 16 and the conduit 18, and operable to block the transmission of sound into the passenger compartment without the necessity of a separate step for installation of the seal 24. If the acoustic seal 24 comprises a part of the dashmat 12, the conduit 18 will be inserted through the acoustic seal 24 and the aperture 19 in a single assembly step after the installation of the dashmat 12. Alternatively, with the acoustic seal 24 provided as a separate element, the acoustic seal 24 will be installed around the conduit 18 and the aperture 19 as the automotive component 16 is placed into position.

[Para 30] Prior art acoustic seals for controlling sound associated with firewall openings serving passenger compartment-mounted components have utilized a sound-blocking barrier layer in register with the perimeter of the component. The acoustic seal described herein provides effective sound control through an acoustic seal having both sound blocking and sound absorption properties. The acoustic seal is readily installed around the perimeter of the aperture either as a part of the dashmat or as a separate element.

[Para 31] While the invention has been specifically described in connection with certain specific embodiments thereof, it is to be understood that this is by way of illustration and not of limitation. For example, the invention is not limited to use of the acoustic seal with a two layer dashmat but can be used with any dashmat that has both barrier and absorption properties, including single layer firm-flexible foam. In fact, the acoustic seal can be used to attenuate sound through any opening in a substrate, regardless of the nature of the substrate. Reasonable variation and modification are possible within the scope of the foregoing description and drawings without departing from the spirit of the invention.